

ENGINEERS AUSTRALIA

ENGINEERING HERITAGE VICTORIA

CEREMONY REPORT

Bendigo Monier Arch Bridges

Heritage Recognition Ceremony

Ceremony held adjacent to Bendigo Creek between Old High Street and High Street, Golden Square, Bendigo, Victoria



Date of ceremony: Saturday 8 August 2014

Crowd at the ceremony at 10:00 am on 8 August 2014. From this position three of the remaining six Monier Arch Bridges can be seen carrying High Street, Booth Street and Wade Street over the Bendigo Creek. The ceremony location is only a few metres from a marker commemorating the discovery of gold, at this spot on the banks of Bendigo Creek at Sandhurst (now Bendigo) in 1851. Almost everything in Bendigo which followed the discovery of gold is in some way related to the gold story. Along with Ballarat, where gold was discovered the same year, Bendigo was one of the richest gold discoveries in the world.

Image: Owen Peake

CONTENTS

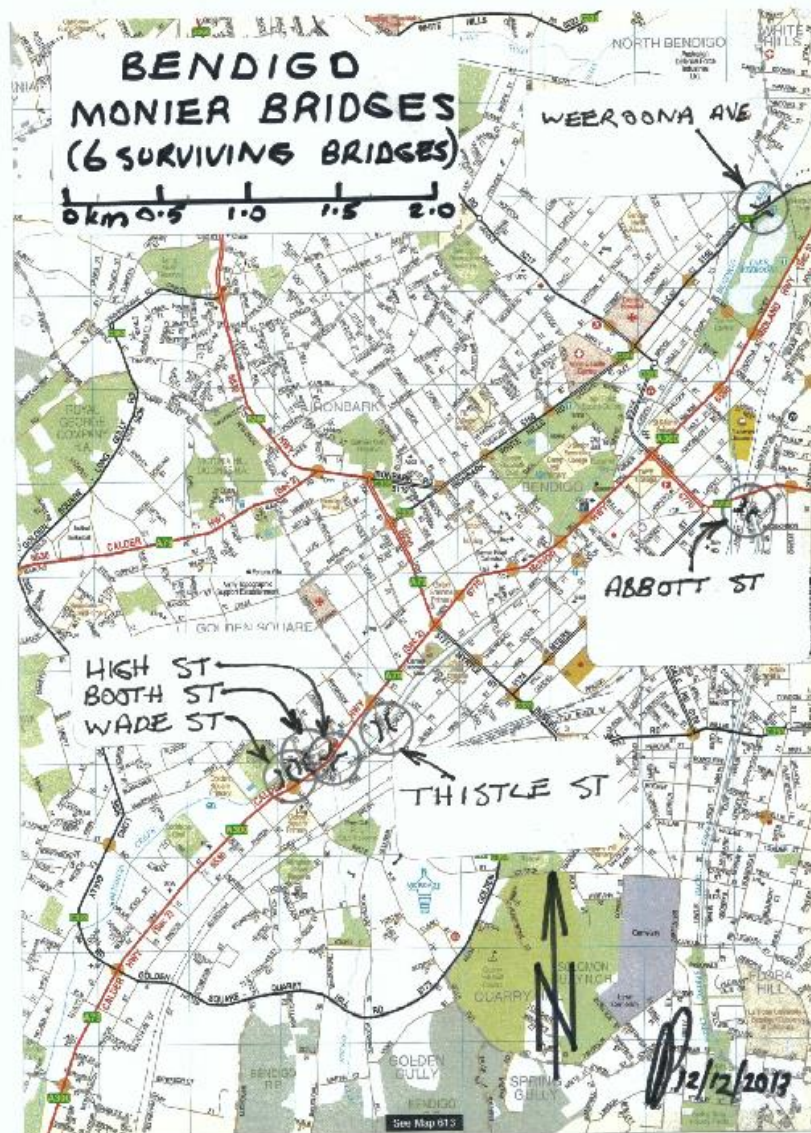
	PAGE
1 Introduction	4
2 Invitations	5
3 Distinguished Guests and Apologies	5
4 Program and Running Sheet	5
5 Speech Notes	5
6 Ceremony Handout	6
7 Media Release	6
8 Media Articles	6
9 Letters of Thanks	6
10 Costing	7
11 Allocation of Tasks	8
12 Interpretation Panel	8
13 Photographs	10
Attachment 1 - Invitation Letter	15
Attachment 2 - Advertising Flyer	16
Attachment 3 - Running Sheet	17
Attachment 4 - Speech Notes – Alex Baitch	20
Attachment 5 - Media Release	24
Attachment 6 - Article for EHA Magazine	25
Attachment 7 - Article for EA Magazine	29
Attachment 8 - Article from Bendigo Advertiser	31
Attachment 9 - Text of Typical Letter of Thanks.	32

1 Introduction:

The ceremony for the marking of the **Bendigo Monier Arch Bridges** with an **ENGINEERING HERITAGE MARKER** was conducted on Saturday 8 August 2014 adjacent to Bendigo Creek between Old High Street and High Street, Golden Square, Bendigo, Victoria at 10:00 am.

The heritage recognition celebrates the 6 remaining bridges of the group of 8 bridges built by Monash & Anderson for the Bendigo Council in 1901/2. Six of the bridges remain in service as shown on the map below.

Attendance: 48



2 Invitations:

There were two forms of invitation:

2.1 Written invitation (see Attachment 1) sent by mail to 154 people listed by Engineering Heritage Victoria. This list consisted primarily of local dignitaries, council representatives, politicians, heritage industry figures and other stakeholders.

2.2 Email invitations (see copy of flyer at Attachment 2) sent to the following address lists:

- Engineering Heritage Victoria list (approx 400 on list)
- Bendigo Regional Group (number not known - say 200)
- Ballarat Regional Group (number not known - say 200)
- Engineering Heritage Australia Member and Corresponding Members (45 on list)

Hence the total number of invitations issues was about 1000. With at total attendance of 48 at the ceremony the response rate is approximately 4.8%.

3. Distinguished Guests and Apologies:

Listed on the Running Sheet. See Attachment 3.

4 Program & Running Sheet:

The Running Sheet (Attachment 3) shows:

- Those who spoke at the event and timing
- Distinguished Guests who were acknowledged
- Apologies received who were acknowledged

The Master of Ceremonies was Mr Tim Dunlop, Chair of the Bendigo Regional Group of Engineers Australia.

5 Speech Notes:

Speech Notes for Alex Baitch are attached at Attachment 4.

Speech notes were not made available by other speakers.

6 Ceremony Handout:

An A5 ceremony handout was prepared and handed out to all those who attended the ceremony. A copy could not be loaded into this document for technical reasons. The handout was based largely on the material from the Interpretation Panels. 150 copies were printed.

7 Media Release:

Engineers Australia issued a Media Release. A copy is at Attachment 5.

8 Media Articles:

8.1 ARTICLE FOR ENGINEERING HERITAGE AUSTRALIA MAGAZINE

Article written by Owen Peake is at Attachment 6.

8.2 ARTICLE FOR ENGINEERS AUSTRALIA MAGAZINE

Article written by Owen Peake is at Attachment 7.

8.3 ARTICLE FROM THE BENDIGO ADVERTISER, 9 AUGUST 2014

Article written by Renee Thompson is at Attachment 8.

9 Letters of Thanks:

Letters on EA Victoria Division letterhead were sent out over Glenda Graham's signature to the following:

A typical draft letter for the above is at Attachment 9.

10 Costing

Costs of the project were incurred as per the following table:

Item No.	Description	Funding Source	Amount
1	Interpretation Panels Manufacture – Glass Metal Industries (2 panels)	City of Greater Bendigo Council and VicRoads (shared 50/50)	\$2860
2	Graphic Design of Interpretation Panels - Richard Venus (2 panels)	EHA Budget (through National Office)	\$800.00
3	Hire of lectern and chairs – Bendigo Party Hire	EHV Budget	\$198.00
4	Manufacture of Mounting Frame for Interpretation Panel – Arranged by City of Greater Bendigo Council	City of Greater Bendigo Council and VicRoads (shared 50/50)	Not known
5	Car travel costs to Owen Peake for delivery of panels from GMI Geelong to Bendigo.	EHV Budget	\$124.50
6	Proof reading of nomination and handout document – Tropical Dragon	EHV Budget	\$142.50
7	Hire of PA system by EA Victoria Office	EHV Budget	\$114.40
8	Printing of Handout documents (150 off) by EA Victoria Office	EHV Budget	\$479.00
9	Provision of morning tea by contract	City of Greater Bendigo Council	Not known
10	Installation of two Interpretation Panel Mounting Frames at Golden Square and Kings Bridge	City of Greater Bendigo Council and VicRoads (shared 50/50)	Not known
11	Provision of two 300mm diameter EHA marker plates - from EA National Office	EHA Budget (through National Office)	\$600 (estimate)
		TOTAL	\$5318.40

The likely cost of the items not costed in the above table is estimated to be about \$2600 making the total cost of the event \$7918.40.

Share of costs are shown in the following table:

Stakeholder	Amount contributed (estimated)	Percentage contribution (approx.)
City of Greater Bendigo	\$2980	38%
VicRoads Bendigo	\$2480	31%
EHA – National Office	\$1400	18%
EHV – Victoria Office	\$1058.40	13%
Total	\$7918.40	100%

11 Allocation of Tasks

A schedule showing the Allocation of Tasks between the various stakeholders was used. This document ensured that all details of organisation were attended to and served as a check list in the run-up to the event.

The tasks of planning of the ceremony were primarily shared between Jessica Bradley in the Victoria Division EA office, Michelle Stedman at City of Greater Bendigo, Mal Kersting at Vicroads Bendigo and Owen Peake, EHV volunteer.

12 Interpretation Panel:

The two interpretation panels have been erected on steel support frames at the following locations:



- On the north bank of Bendigo Creek about 100 metres west of High Street, Golden Square, Bendigo. The panel is adjacent to a bike path which follows the creek bank.
- At the north-west corner of the Kings Bridge adjacent to Weeroona Avenue. The panel is in a small park below a large pepper corn tree.

The panels are 1200 mm wide and 600 mm high and produced in by screen printing in vitreous enamel-on-steel by Glassmetal Industries Pty Ltd. The Engineering Heritage Markers are mounted on the cross bar below the interpretation panel. These markers are the standard 300 mm diameter vitreous enamel-on-steel marker used by EHA.

Golden Square Panel

Monier Arch Bridges in Bendigo

Early Use of Reinforced Concrete in Victoria

Monash & Anderson

The Bendigo bridges were designed and built by the Melbourne consulting engineers Monash & Anderson who started in 1884.

Governor Sir John Monash (1866 - 1931)

Later, in 1885, John Monash set up the Reinforced Concrete & Monier Pipe Construction Co which continued to develop the use of reinforced concrete in Victoria. Following a brilliant military career in World War I Monash became Chairman of the State Electricity Commission of Victoria and led the effort to use Latrobe Valley brown coal to generate electricity.


Joseph Anderson (1841 - 1914)

Joseph Anderson's engineering career has been overshadowed by Monash's military fame. Anderson worked in various disciplines, then went to New Zealand, and later worked as a municipal and consulting engineer in Victoria.

Bendigo Arch Bridges

Six of the eight bridges are still in use today


1. Oak Street
2. King's Bridge (Weeroona Avenue)
3. Booth Street
4. High Street
5. Waite Street
6. Abbott Street
7. Myrtle Street
8. Thistle Street



Why an Arch Bridge?

The greatest stress of an arch bridge transfers some of the weight of the bridge and its traffic into a balanced force reduced by its abutments. Larger bridges may have several arches supported by piers in the middle. They're simple, they work, and they can be quite pleasing to appreciate.

To build a Monier arch bridge, Joseph Anderson was creative and used reinforcement to his advantage. Then the concrete was poured into the form - in the 1880s they used sheetpiling. When the concrete had gained sufficient strength, the formwork was removed.




From Pots to Ponto

French horticulturalist Joseph Monier devised a method of making flower pots and garden furniture by using a mesh of iron rods to reinforce concrete. He took out a patent in 1857 and continued to find new uses for the method which enables the best use of such material.


The technique was soon applied to other structures and in 1876 Monier designed the first reinforced concrete bridge (Pont is the French word for bridge).

In the early 1880s the Sydney firm of Carter, Gurnsey & Co acquired the rights to build Monier bridges in Australia.



In 1887 Monash & Anderson began a link with them and obtained sole rights to the Monier patent in Victoria.




Engineering Heritage Market
opened on 14 June 2014



CITY OF GREATER BENDIGO



Kings Bridge (Weeroona Avenue) Panel


Monier Arch Bridges in Bendigo

Disaster at King's Bridge

Bendigo Bridges

Eight Monier arch bridges were built along the Bendigo Creek in 1881 to 1882 using a new material - reinforced concrete. Six are still in use today.

1. Oak Street
2. King's Bridge (Weeroona Avenue)
3. Booth Street
4. High Street
5. Waite Street
6. Abbott Street
7. Myrtle Street
8. Thistle Street



You'll find more information about Bendigo's arch bridges at the Bendigo Creek - or down the CRT code below

One Arch or Two?

Originally all eight bridges were designed as wide single arch structures. Following a shocking accident at the King's Bridge when a section of the arch collapsed during the last test - killing a contractor, Albert Reid - the bridge was re-designed to have two spans and a central supporting pier, reducing stresses in the arches.

The Bendigo Advertiser

A SHOCKING ACCIDENT.
SERIOUS INJURY TO A WELL-KNOWN CONTRACTOR KILLED.
FATAL INJURY TO A WELL-KNOWN CONTRACTOR KILLED.

On the night of the 14th inst. a section of the arch of the King's Bridge collapsed during the last test. The bridge was re-designed to have two spans and a central supporting pier, reducing stresses in the arches.


How did it happen?

The safety of a bridge is heavily dependent on the quality of the materials used. At King's Bridge, a steam roller used for the last - together they weighed 30 tons which was far in excess of the load limit of 20 tons. During the test, one section collapsed. The traction engine fell into the creek bed, dragging the roller with it and causing the bridge to collapse.

Monash & Anderson could not understand why the bridge had failed and engaged Professor William Kermack from Melbourne University to investigate. He concluded that the large angle of stress had produced four times the expected stress in the bridge. Even today, engineers would find it difficult to analyse such a highly stressed structure. Monash & Anderson replaced the bridge at their own expense.


The New King's Bridge

The two-span Monier arch bridge still carries traffic today. Alongside it is a new reinforced concrete arch bridge built in 2004. The road (now called Weeroona Avenue) was widened and a new road surface laid. However, from underneath, the two supporting structures can be clearly seen. The new King's Bridge was opened on 14 May 2004.




The Bendigo Creek



Sludge from the river had been allowed to run into Bendigo Creek, filling up the creek bed with silt and other debris. Engineers recommended clearing the sludge (which still contained some gold), redesigning the creek, and protecting the barrier with timber sheetpiling. Heavy silt had to be removed from the creek. After years of doing work, finally began on the creek in May 1888.




Engineering Heritage Market
opened on 14 June 2014



CITY OF GREATER BENDIGO



13 Photographs:



Mayor Barry Lyons speaking to the guests at the ceremony.
Image: Owen Peake



Mal Kersting from VicRoads Bendigo speaking to the guests at the ceremony.
Image: Owen Peake



Mayor Barry Lyons, Alex Baitch, National President of Engineers Australia and Mal Kersting, Regional Director of VicRoads unveil the interpretation panel.
Image: Owen Peake



Students Justin Leaney and Steve Money with the interpretation panel. They wrote the nomination as part of the Work Experience Project with Victoria University.
Image: Owen Peake



The interpretation panel at Golden Square with the Bendigo Creek in the background.
 In the image are Owen Peake, Chair of EHV, Engineers Australia National President
 Professor Alex Baitch and Victoria Division President Geoff Hayes.
Image: Jessica Bradley



The interpretation panel at Kings Bridge with the bridge in the background.
Image: Owen Peake



High Street Bridge from near the site of the Golden Square interpretation panel and ceremony.

Image: Owen Peake



Booth Street Bridge from near the site of the Golden Square interpretation panel and ceremony.

Image: Owen Peake

Attachment 1 - Invitation Letter

ENGINEERS AUSTRALIA VICTORIA DIVISION

Dear.....

Monier reinforced concrete bridges built by Monash & Anderson in Bendigo 1901-02

In the very early years of the 20th century a young John Monash and his partner Joshua Anderson held patent rights for Monier reinforced concrete structures in Victoria and South Australia. They were particularly interested in building arch bridges using the Monier system and already had several important bridges built at Fyansford near Geelong and Wheelers Bridge north of Ballarat.

The Council in Bendigo was in the process of cleaning up Bendigo Creek which ran through the centre of town and had been badly affected by alluvial gold mining in the creek.

Monash & Anderson obtained a contract from the Council to build eight fairly modest single span bridges. All the bridges were completed and six of them remain in service.

There was a disaster during the project when the Kings Bridge failed under test, killing one man. The problem was neither the Monash & Anderson design nor the construction – the standards of the day for skewed bridges were incorrect. Monash & Anderson rebuilt the bridge with two spans and it remains in service today.

Join Engineering Heritage Victoria, Greater Bendigo City Council and VicRoads in recognising the significance of the Bendigo Monier bridges with Engineering Heritage Markers on Saturday 9 August 2014 at 10:00 am at 9 Old High Street, Golden Square.

All are welcome to attend.

Yours sincerely


Glenda Graham

Attachment 2 - Advertising Flyer

Engineering Heritage Victoria (EHV)

Bendigo Monier Arch Bridges

Heritage Marking Ceremony



**ENGINEERS
AUSTRALIA**

VENUE

Old High Street
Near Ophir Street
Bendigo
Vicroads Country Directory:
Map 607, Ref P8



DATE & TIME

Saturday 9 August
9:45am for 10am sharp -
10:30am
This event is FREE to attend,
all are welcome.

REGISTRATIONS

REGISTER ONLINE

[www.engineersaustralia.org.au/
events/bendigo-monier-arch-
bridges-heritage-recognition-
ceremony](http://www.engineersaustralia.org.au/events/bendigo-monier-arch-bridges-heritage-recognition-ceremony)

Around the turn of the twentieth century the Bendigo Council decided to clean up Bendigo Creek which ran through the centre of Bendigo. The creek had been the scene of frantic gold mining activities during the Gold Rush and this left it in need of repair to prevent frequent flooding.

The creek was straightened, widened and reformed to run in a formal channel. Existing bridges had to be replaced to span the rebuilt creek.

The Council sought proposals for eight new bridges and after much negotiation the contract was let to Melbourne-based Monash & Anderson for Monier patent reinforced concrete arch bridges. The bridges were small, all originally involving single span structures.

The bridges were built during 1901-2 but during testing one bridge, Kings Bridge collapsed causing the death of one man. Monash & Anderson rebuilt the bridge with two spans and it survives, in service, along with five of the other bridges. Two bridges have been replaced.

Engineering Heritage Victoria in partnership with owners, City of Greater Bendigo (four of the bridges) and VicRoads (two of the bridges) will recognise the bridges with Engineering Heritage Markers.

This community event is FREE to attend. All are welcome.

For further information contact Marketing and Event Coordinator – Jessica Bradley
Phone: 03 9321 1722 | Email: jbradley@engineersaustralia.org.au

Attachment 3 - Running Sheet

CONTACT LIST

Engineers Australia Key Staff

Glenda Graham	Executive Director	0434 070 688
Jessica Bradley	Marketing & Events Coordinator	0433 651 475

Engineers Australia Key Stakeholders

Alex Baitch	National President	0412 344 821
John McIntosh	National Councillor	0418 128 121
Carla Cher	National Councillor	

Other Event Key Stakeholders

EHV Member

Owen Peake	Chair, EHV	0402 933 328
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Event Sponsor Representatives

Tim Dunlop	Chair Engineers Australia, Bendigo Group	
Barry Lyons	Mayor, City of Greater Bendigo	(03) 5434 6215 0429 292 084
Michelle Stedman	PA to Brett Martine, City of Greater Bendigo	(03) 5434 6074 0401 560 605
Mal Kersting	Regional Director, Northern Victoria, VicRoads	0417 013 652

KEY EVENT INFORMATION

Topic: BENDIGO MONIER ARCH BRIDGES Engineering Heritage Recognition Ceremony

Date: Saturday 9 August 2014

Time: 10:00 am to 10:35 am

Venue: Old High Street near Ophir Street, Bendigo

[The venue will be outside in the street and there will be no cover in the event of rain – suggest bring an umbrella]

RUN SHEET

Time	Action	Responsible
9:00am–9:45am	Set Up Site – banners, chairs (reservations), speakers, lectern, booklets, PA system	Jess/Owen/Council/VicRoads
9:45am– 10:00am	Guests arrive Greet Guests/Handout booklets	Jess/Owen/Council/VicRoads
10:00am– 10:05am	Speeches to commence Welcome by Master of Ceremonies Tim Dunlop, Chair, Bendigo Group of Engineers Australia <ul style="list-style-type: none"> Welcome to the event Welcome to Country – “On behalf of the city of Greater Bendigo I would like to acknowledge the traditional owners of the land we are standing on today – the Jarra people”. Point out location of the closest toilets. Take care on the road behind you. Acknowledgment of Distinguished Guests and Apologies (see next page for details). 	MC
10:06am– 10:12am	Professor Alex Baitch, National President, Engineers Australia	Alex Baitch
10:13am– 10:19am	Mayor Barry Lyons, City of Greater Bendigo	Barry Lyons
10:20am– 10:26am	Mal Kersting, Regional Director, Northern Victoria, VicRoads	Mal Kersting
10:27am– 10:31am	MC invites Alex Baitch, Mayor Barry Lyons, and Mal Kersting to unveil the interpretation panel and pose for photos. Photos to be taken of marker unveiling.	Official Party Jess/Owen
10:32am– 10:35am	Closing remarks by MC <ul style="list-style-type: none"> Thanks to: Council, VicRoads; Staff of Engineers Australia Victoria Division and all the speakers at the ceremony. Invite those attending to afternoon tea. 	MC
10:35am– 11:00am	Pack up	Jess/Owen

DISTINGUISHED GUESTS TO BE ACKNOWLEDGED

- Professor Alex Baitch, National President, Engineers Australia
- Mayor, Barry Lyons, City of Greater Bendigo
- Mal Kersting, Regional Director, Northern Victoria, VicRoads
- National Councillor John McIntosh, Engineers Australia

APOLOGIES TO BE ACKNOWLEDGED

- Brett Martini, Manager, Engineering & Public Space, City of Greater Bendigo
- National Councillor Carla Cher, Engineers Australia

Attachment 4 - Speech Notes – Alex Baitch

SPEECH NOTES – ALEX BAITCH – FOR BENDIGO BRIDGES HERITAGE RECOGNITION CEREMONY – 9 AUGUST 2014

Ladies and Gentlemen:

Heritage Recognition Program

- Engineering Heritage is one of the foundation building blocks of the **learned body function** of **Engineers Australia**.
- Engineers require a knowledge of the history of their profession and the achievements of the engineers that went before them in order to understand how the profession developed over time and to learn from the mistakes made in the past.
- **Only by understanding the past can we hope to find better ways of doing things in the future.**
- The **Heritage Recognition Program** aims to join with local communities to **recognise** and **celebrate** the great engineering achievements of the past in their communities.
- The past can be two centuries ago or just last year. In this case we are recognising a group of bridges built in the very early years of the 20th century.
- Ceremonies such as this one form the central plank of the **Heritage Recognition Program**.
- This recognition ceremony celebrates the **182nd work** recognised under the **Heritage Recognition Program**.
- The program has been in place since 1984 and every year ten to fifteen sites around Australia are recognised at ceremonies such as this one.

Innovation and Engineering Heritage

- Some engineering heritage is particularly important in that it incorporates innovations in engineering which were new at the time of construction. **In some cases the new concepts changed almost everything which followed.**
- **These bridges represent such a case.**
- We should also take careful note of the engineers who were involved in engineering heritage. Some were giants whose innovations literally changed the world. These bridges here in Bendigo may look somewhat modest to the modern eye but the men behind them were visionaries who were prepared to take great risks to implement innovative technology.
- **The key individuals in this case were General Sir John Monash and Joshua Anderson.** They made a huge contribution to the modern world.
- Before Monash & Anderson started to use the Monier patents in Victoria & South Australia there were very few concrete bridges in this part of the world.
- They took risks, sold the new innovations with great vigour and, after much heartache, they successfully demonstrated reinforced concrete technologies which remain familiar today.
- Until the Monier patents were applied most bridges were built of masonry, wrought iron or of timber. Masonry could only be used for arch bridges where it was in compression. Wrought iron had to be imported and was expensive and took a long time to deliver from the UK. Timber lacked durability and was terribly vulnerable to bush fire and flood damage. Concrete, before Monier, was good in compression but poor in tensile strength. Monier added iron (or steel) to the structure to give concrete structures tensile strength. Now we can build soaring concrete structures of reinforced concrete. These structures are not only strong but have a very long life.

- These early Monier arch bridges mark the beginning of the use on reinforced concrete for structures such as bridges. **That makes them very important waypoints in the history of engineering.**
- Consider this – during almost every journey by road or rail we cross reinforced concrete bridges in large numbers. Most are small, standard designs from the standard drawings of VicRoads or Municipal Councils and we cross them without much thought. Now and again we cross a big concrete bridge such as the mighty Gladesville Bridge in Sydney Harbour, which held the “longest span for a concrete bridge” record for a long time.
- Monash cut his teeth on the Monier patent arch bridges but he was an innovator and soon moved on. It is said that Monash led in reinforced concrete girder bridge design and construction in Australia ¹.
- The impressive Janevale Bridges on the Loddon River at Laanecoorie just 40 km to the west of Bendigo, built in 1910-11 shows just how quickly the fertile minds of Monash and Anderson moved. To the casual observer the Janevale Bridge looks very little different to modern “T” beam bridges.
- Whilst modern “T” beam bridges incorporate off-site fabrication of the beam and pre-stressing techniques they look much the same. The use of large mobile cranes has also contributed to the capability of modern bridge engineers to build impressive bridges quickly.
- Monash innovated constantly. **Innovation was in his nature and such an important engineer must be remembered.**
- We tend to think of General Sir John Monash more as a soldier than as an engineer. It is also true that Joshua Anderson was somewhat overshadowed by his famous partner.

¹ Alan Holgate. Note that Anderson had left the firm before the first “T” girder bridge was built. Monash’s innovation came with the T-girder bridges. Monier Arch bridge computations were based on well-established methods developed for stone arches, page 3 Monier bridges Alves, Holgate, Taplin

- However we should also remember that **John Monash was as much an innovator on the battlefield as he was on the bridge sites of Bendigo.**
- He planned his battles with a level of detail and precision which confounded the enemy. He grasped and applied the concept of **“integrated force”** – using infantry, artillery, tanks and aircraft in close co-ordination to reinforce his attacks in such a way that he literally terrified the enemy into submission. Perhaps he regarded the battle plan as an engineering challenge? It is certainly true that he captured vast amounts of ground on the Western Front and brought World War I to an end much more quickly than had he not been involved. However that is another story.
- Victorians (in particular) revere John Monash. **We in the engineering profession can do worse that remember that this giant of his time was first and foremost an engineer.**

Thank you.

Attachment 5 - EA Media Release

MEDIA RELEASE



6 August 2014

No bridge too far for Bendigo Engineering Heritage Markers

Six historic Bendigo Monier arch bridges will be awarded Engineering Heritage Markers in a ceremony **this Saturday**.

"Between 1901 and 1902 eight bridges – of which six still stand and carry traffic – were built in the Bendigo area by the Monash & Anderson engineering company, led by General Sir John Monash who went on to be a military commander in World War I," says Mr Owen Peake, Chair of Engineers Australia's Victorian Heritage Committee.

"These Monier arch bridges were built using reinforced concrete; both the design and material were novel at the time. The gracefully curved design of the bridge transfers some of the weight of the bridge and its traffic to a horizontal force resisted by the abutments, lending it significant strength.

"The Monier arch bridge design has since been superseded by bridges of T-shaped concrete beams, but represent an important 'stepping stone' in the development of reinforced concrete bridges. Monier arch bridges took us from masonry and timber bridges to the reinforced concrete bridges we see today.

"Originally all eight bridges were designed as wide single arch structures. Following an accident at the King's Bridge in 1901 – when a section of the arch collapsed during the load test, killing contractor Albert Boldt – the bridge was redesigned to have two spans and a central supporting pier, and still stands strong today.

"At the turn of the century when these bridges were built, Australia was undergoing a transformation into a car loving nation. These bridges helped Bendigo and the surrounding area evolve into the city we see today" said Mr Peake.

Bendigo Monier Bridges Heritage Recognition Ceremony

When: 9.45am – 10.30am, Saturday 9 August 2014

Where: Old High Street near Ophir Street, Bendigo, Victoria

Historical images of the bridges available on page two.

Media Contact:

Casey Hamilton | Media Coordinator Engineers Australia

Email: chamilton@engineersaustralia.org.au | Phone: (02) 6270 6559 | After hours: 0402 419 962

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Engineers Australia is the peak representative body for the engineering profession, representing more than 100,000 members from all disciplines of the engineering team. We maintain representation in every state and territory.

Attachment 6 - Article – EHA Magazine

Major bridge innovation in Bendigo over 100 years ago

Joseph Monier (1823 - 1906) was a French gardener and one of the principal inventors of reinforced concrete. He was looking for a way to produce unbreakable planter troughs. He experimented with concrete embedded with iron mesh and got his first patent for these in 1867 and another for bridges made with iron reinforced concrete in 1873. He built the first reinforced concrete arch bridge over the moat of the chateau de Chazelet in 1875. It had a span of about 15 metres. The first reinforced concrete arch bridge in America was built in 1889. It is still extant in San Francisco's Golden Gate Park (American Society of Civil Engineers). In Victoria the engineering firm of John Monash (later General Sir John Monash) & Joshua Anderson obtained rights for the use of the Monier patent in Victoria and South Australia, and built many bridges using the method. The Fyansford Bridge near Geelong was their first Monier arch bridge to go into service, in late 1899. Next was Wheeler's Bridge, near Creswick in Victoria, completed in 1900. The eight Bendigo Bridges – the subject of this story – were next.

Engineering Heritage Victoria (EHV) has had a sub-program within its Heritage Recognition work to recognise structures designed or built by General Sir John Monash, the firm Monash and Anderson or later iterations of companies with which Monash was associated, as a contribution towards the celebration of the centenary of the ANZAC Campaign in 2015. Heritage recognition ceremonies so far accomplished for Monash works include the bridges mentioned above, the Janevale Bridge at Laanecoorie Victoria and the Yallourn Power Station in the Latrobe Valley, built while Monash was Chairman of the State Electricity Commission of Victoria in the 1920s.

In 1901-02 Monash and Anderson were contracted to build eight single span reinforced concrete arch bridges over Bendigo Creek (one of the bridges was on a tributary called Back Creek) for the Council as part of a project to formalise the creek after it had been subject to gold-winning operations. Six of the bridges remain in service.

The eight bridges were:

- King's Bridge over what is now called Weeroona Avenue. This bridge had a span of 28.5 metres. This bridge failed under test on 14 May 1901 and was subsequently rebuilt as a two span bridge which remains in service. The bridge was widened by adding a new bridge of similar appearance in 2004.
- Abbott Street Bridge (over Back Creek). The single span bridge appears to have had an uneventful life and is still in service.
- High Street Bridge carries what is now the Calder Highway over Bendigo Creek. This bridge was always regarded as a highway bridge and is wider than the other bridges in the group, carrying four traffic lanes. The single span bridge appears to have had an uneventful life and is still in service.
- Thistle Street Bridge. This bridge shows a little more "flattening" at the crown of the arch than the other bridges. However the single span bridge appears to have had an uneventful life and is still in service.
- Booth Street Bridge. The single span bridge appears to have had an uneventful life and is still in service.

- Wade Street Bridge. The single span bridge appears to have had an uneventful life and is still in service. Curiously this bridge no longer has its bluestone coping stones on the top of the parapet walls. It is not known why. Were the walls rebuilt at some time or was the bridge originally constructed with the simple concrete coping slab present today?
- Oak Street Bridge has been replaced by a new bridge. It is thought that the motive for the replacement was the need for greater width rather than any failure of the original bridge.
- Myrtle Street Bridge has been replaced by a new bridge. It is thought that the motive for the replacement was the need for greater width rather than any failure of the original bridge.

Except for the rebuilt King's Bridge, with its two spans and metal parapet fences, the other bridges were very similar. The arches and spandrel walls are concrete; the parapet walls are brick with a row of bluestone blocks at the base of the parapet wall and as a coping except for Wade Street as mentioned above.

Some engineering heritage is particularly important in that it incorporates innovations in engineering which were new at the time of construction. In some cases the new concepts changed almost everything which followed. These bridges represent such a case.

We should also take careful note of the engineers who were involved in our engineering heritage. Some were giants whose innovations literally changed the world. These bridges in Bendigo may look somewhat modest now but the men behind them were visionaries who were prepared to take great risks to implement innovative technology.

The key individuals in this case were business partners John Monash (later General Sir John Monash) and Joshua Anderson. They made a huge contribution to the modern world.

Before Monash & Anderson started to use the Monier reinforced concrete patents there were very few concrete bridges in this part of the world.

They took risks, sold the new innovations with great vigour and, after much heartache, successfully demonstrated reinforced concrete technologies which remain familiar today.

Until the Monier patents were applied most bridges were built of masonry, wrought iron or of timber. Masonry could only be used for arch bridges where it was in compression. Wrought iron had to be imported and was expensive and took a long time to deliver from the United Kingdom. Timber lacked durability and was terribly vulnerable to bush fire and flood damage. Concrete, before Monier, was good in compression but poor in tensile strength. Monier added wrought iron (or later steel) to the structure to give concrete structures tensile strength. Now we can build soaring concrete structures of reinforced concrete. These structures are not only strong but have a very long life.

The early Monier arch bridges mark the beginning of the use of reinforced concrete for structures such as bridges. That makes them very important waypoints in the history of engineering.

The Bendigo project was not without problems. The King's Bridge failed under test when the Council engineer increased the agreed test loadings and one man was killed. Monash & Anderson rebuilt the bridge as a two-span structure at their own cost. They also engaged Professor Kernot, a highly respected academic of the era, to try to understand the cause of the failure. It became clear that the failure did not stem from material deficiencies, construction errors or problems with the design calculations. Rather the

investigation revealed that the informal design standards of the day were deficient in dealing with highly skewed bridges.

So where did concrete bridge development go after the Monier bridges? We only need to look at where concrete bridges now stand to see something of what happened.

Monash cut his teeth on the Monier patent arch bridges but he was an innovator and soon moved on. It is said that Monash led in reinforced concrete girder bridge design and construction in Australia after Anderson left the partnership.

The impressive Janevale Bridge on the Loddon River at Laanecoorie just 40 km to the west of Bendigo, built in 1910-11 shows just how quickly the fertile mind of Monash moved. To the casual observer the Janevale Bridge looks very little different to modern “T” beam bridges.

During almost every journey by road or rail we cross reinforced concrete bridges in large numbers. Most are small, standard designs, built to the standard drawings of road and rail authorities, and we cross them without much thought. Now and again we cross a big concrete bridge such as the mighty Gladesville Bridge in Sydney Harbour, which held the “longest span for a concrete arch bridge” record for 16 years.

Whilst modern “T” beam bridges incorporate off-site fabrication of the beams and pre-stressing techniques they look much the same. The use of modern trucks and large mobile cranes has also contributed to the capability of modern bridge engineers to build impressive bridges quickly.

We tend to think of General Sir John Monash more as a soldier than as an engineer. We should remember that John Monash was as much an innovator on the battlefield as he was on the bridge sites of Bendigo.

He planned his battles with a level of detail and precision which confounded the enemy but which would be familiar to engineers. He grasped and applied the concept of “integrated force” – using infantry, artillery, tanks and aircraft in close co-ordination to reinforce his attacks in such a way that he literally terrified the enemy into submission. Perhaps he regarded the battle plan as an engineering challenge? It is certainly true that he captured vast amounts of ground on the Western Front and brought World War I to an end much more quickly than had he not been involved. However that is another story.

We in the engineering profession can do worse than remember that this giant of his time was first and foremost an engineer.

Engineering Heritage Victoria conducted a heritage recognition ceremony in Bendigo on 9 August 2014 with partners City of Greater Bendigo and VicRoads. The marker and interpretation panel are erected between High Street Bridge and Booth Street Bridge on the bank of Bendigo Creek and within a few metres of the point where the first gold was found in Bendigo. Bendigo made a huge economic contribution to the development of Victoria during its incredible Gold Rush but perhaps the emergence of the reinforced concrete bridge was an even richer treasure.

PHOTO CAPTIONS

- 1) Abbott Street Bridge, Bendigo. *Image: Owen Peake*

Photo ID: Abbott Street Bridge Bendigo DSC_0415

- 2) King's Bridge, Bendigo. *Image: Owen Peake*

Photo ID: Kings Bridge Bendigo DSC_0404

- 3) Detail of Booth Street Bridge, Bendigo. *Image: Owen Peake*

Photo ID: Booth Street Bridge Bendigo DSC_0824

- 1) Thistle Street Bridge showing some "flattening" of the arch crown. *Image: Owen Peake*

Photo ID: Thistle Street Bridge.Bendigo DSC_0432

Attachment 7 – Article – EA Magazine

Bendigo Monier reinforced concrete arch bridges

In 1901-02 Monash and Anderson were contracted to build eight single span reinforced concrete arch bridges over Bendigo Creek (one of the bridges was on a tributary called Back Creek) for the Council as part of a project to formalise the creek after it had been subject to gold-winning operations. Six of the bridges remain in service.

Some engineering heritage is particularly important in that it incorporates innovations in engineering which were new at the time of construction. In some cases the new concepts changed almost everything which followed. These bridges represent such a case.

We should also take careful note of the engineers who were involved in engineering heritage. Some were giants whose innovations literally changed the world. These bridges in Bendigo may look somewhat modest now but the men behind them were visionaries who were prepared to take great risks to implement innovative technology.

The key individuals in this case were business partners John Monash (later General Sir John Monash) and Joshua Anderson.

Before Monash & Anderson started to use the Monier reinforced concrete patents in Victoria & South Australia there were very few concrete bridges.

They took risks, sold the new innovations with great vigour and, after much heartache, successfully demonstrated reinforced concrete technologies which remain familiar today.

Until the Monier patents were applied most bridges were built of masonry, wrought iron or timber. Masonry could only be used for arch bridges where it was in compression. Wrought iron had to be imported and was expensive and took a long time to deliver from the United Kingdom. Timber lacked durability and was terribly vulnerable to bush fire and flood damage. Concrete, before Monier, was good in compression but poor in tensile strength. Monier added wrought iron (or later steel) to the structure to give concrete structures tensile strength. Now we can build soaring concrete structures of reinforced concrete. These structures are not only strong but have a very long life.

The early Monier arch bridges mark the beginning of the use on reinforced concrete for structures such as bridges. That makes them very important waypoints in the history of engineering.

Monash cut his teeth on the Monier patent arch bridges but he was an innovator and soon moved on. It is said that Monash led in reinforced concrete girder bridge design and construction in Australia after Anderson left the partnership.

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moved. To the casual observer the Janevale Bridge looks very little different to modern concrete girder bridges.

We tend to think of General Sir John Monash more as a soldier than as an engineer. John Monash was as much an innovator on the battlefield as he was on the bridge sites of Bendigo.

He planned his battles with a level of detail and precision which confounded the enemy. He grasped and applied the concept of “integrated force” – using infantry, artillery, tanks and aircraft in close co-ordination to reinforce his attacks in such a way that he literally terrified the enemy into submission. Perhaps he regarded the battle plan as an engineering challenge? It is certainly true that he captured vast amounts of ground on the Western Front and brought World War I to an end much more quickly than had he not been involved. However that is another story.

We in the engineering profession can do worse than remember that this giant of his time was first and foremost an engineer.

Engineering Heritage Victoria conducted a heritage recognition ceremony in Bendigo on 9 August 2014 with partners City of Greater Bendigo and VicRoads to recognise the bridges.

Owen Peake
Engineering Heritage Victoria

PHOTOGRAPH CAPTION

High Street Bridge Bendigo, one of the six bridges still in service. *Image: Owen Peake*

Image ID: High Street Bridge Bendigo DSC_0827

Attachment 8 – Article – Bendigo Advertiser

32

NEWS

Saturday, August 9, 2014

bendigoadvertiser.com.au

Engineers acknowledge historical and heritage significance

Arch bridges celebrated

BY RENEE THOMPSON

ENGINEERS from across Victoria will travel to Bendigo on Saturday to attend a ceremony recognising the heritage significance of six historic Bendigo Moulter arch bridges.

Built between 1901 and 1902 from reinforced concrete - which was novel at the time - six of the eight original bridges still carry traffic and will be awarded Engineering Heritage Markers.

Named after French horticulturalist Joseph Moulter, who designed the first iron reinforced concrete bridge, the Bendigo bridges were built by Melbourne consulting engineers Monash and Anderson.

Saturday's Engineering Heritage Recognition ceremony aims to help tell the story of the bridges, the majority of which are situated on Bendigo Creek in central Bendigo.

Engineers Australia Bendigo chair Tim Dunlop said about 50 or 60 people were expected to attend the early morning ceremony.



SIGNIFICANT: An old photo taken of the second King's Bridge. Picture courtesy: Melbourne University Archives

which will be held from 9.45am to 10.30am at Old High Street bridge, near Ophir Street.

At the ceremony, VicRoads Northern Victoria regional director Mal Kersting, City of Greater Bendigo mayor Barry Lyons, and Engineers Australia national deputy

president Alex Batch will unveil plaques and an interpretation panel for the bridges. He said the bridges' significance was two fold.

"The first was in a technology change in a way bridges were made from then on," he said.

"The second, more

important element is that it would have brought about changes in commuting behaviour, such as allowing transport across the Bendigo Creek, which would have been a significant change to Bendigo in its time."

Engineers Australia's Victorian Heritage

Committee chairman Owen Peake said the bridges represented an important stepping stone in the development of reinforced concrete bridges.

"Moulter arch bridges took us from masonry and timber bridges to the reinforced concrete bridges we see

today," he said. "Originally all eight bridges were designed as wide single arch structures. Following an accident at the King's Bridge in 1901 - when a section of the arch collapsed during the final test, killing contractor Albert Boldt - the bridge was re-designed to have two spans and a central supporting pier, and still stands strong today."

Owen Peake

"At the turn of the century when these bridges were built, Australia was undergoing a transformation into a

city loving nation. These bridges helped Bendigo and the surrounding area evolve into the city we see today."

Attachment 9 - Body of typical thank you letter

ENGINEERS AUSTRALIA VICTORIA DIVISION

Dear.....

Monier reinforced concrete bridges built by Monash & Anderson in Bendigo 1901-02

In the very early years of the 20th century a young John Monash and his partner Joshua Anderson held patent rights for Monier reinforced concrete structures in Victoria and South Australia. They were particularly interested in building arch bridges using the Monier system and already had several important bridges built at Fyansford near Geelong and Wheelers Bridge north of Ballarat.

The Council in Bendigo was in the process of cleaning up Bendigo Creek which ran through the centre of town and had been badly affected by alluvial gold mining in the creek.

Monash & Anderson obtained a contract from the Council to build eight fairly modest single span bridges. All the bridges were completed and six of them remain in service.

There was a disaster during the project when the Kings Bridge failed under test, killing one man. The problem was neither the Monash & Anderson design nor the construction – the standards of the day for skewed bridges were incorrect. Monash & Anderson rebuilt the bridge with two spans and it remains in service today.

Join Engineering Heritage Victoria, Greater Bendigo City Council and VicRoads in recognising the significance of the Bendigo Monier bridges with Engineering Heritage Markers on Saturday 9 August 2014 at 10:00 am at 9 Old High Street, Golden Square.

All are welcome to attend.

Yours sincerely

Glenda Graham

Report prepared by:

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